Ch 10: Skeletal Muscle Tissue (Myology)

main objectives:

1) **Describe the distinguishing characteristics of the different muscle tissues**
2) **Discuss the organization of skeletal muscle**
3) **Explain the micro-anatomy of a skeletal muscle fiber**
4) **Describe the fascicle arrangement in different types of muscle**
5) **Review general muscle terminology**

Developed by
John Gallagher, MS, DVM

LAS POSITAS COLLEGE

Types of Muscle Tissue

One of the 4 primary tissue types

- Skeletal = Striated = Voluntary
  - 40 % of weight
- Cardiac (involuntary)
- Smooth (involuntary, nonstriated

Musculus = little mouse

Made up of many tissue types.

> 700 skeletal muscles

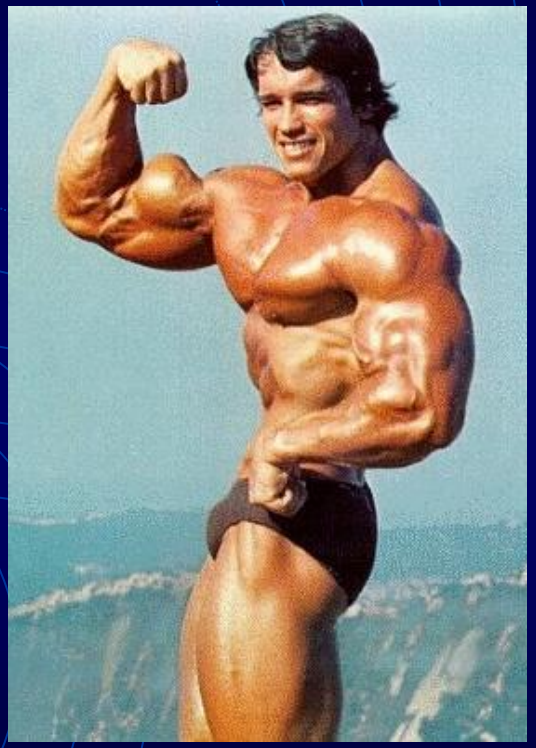
Word roots:

sarco

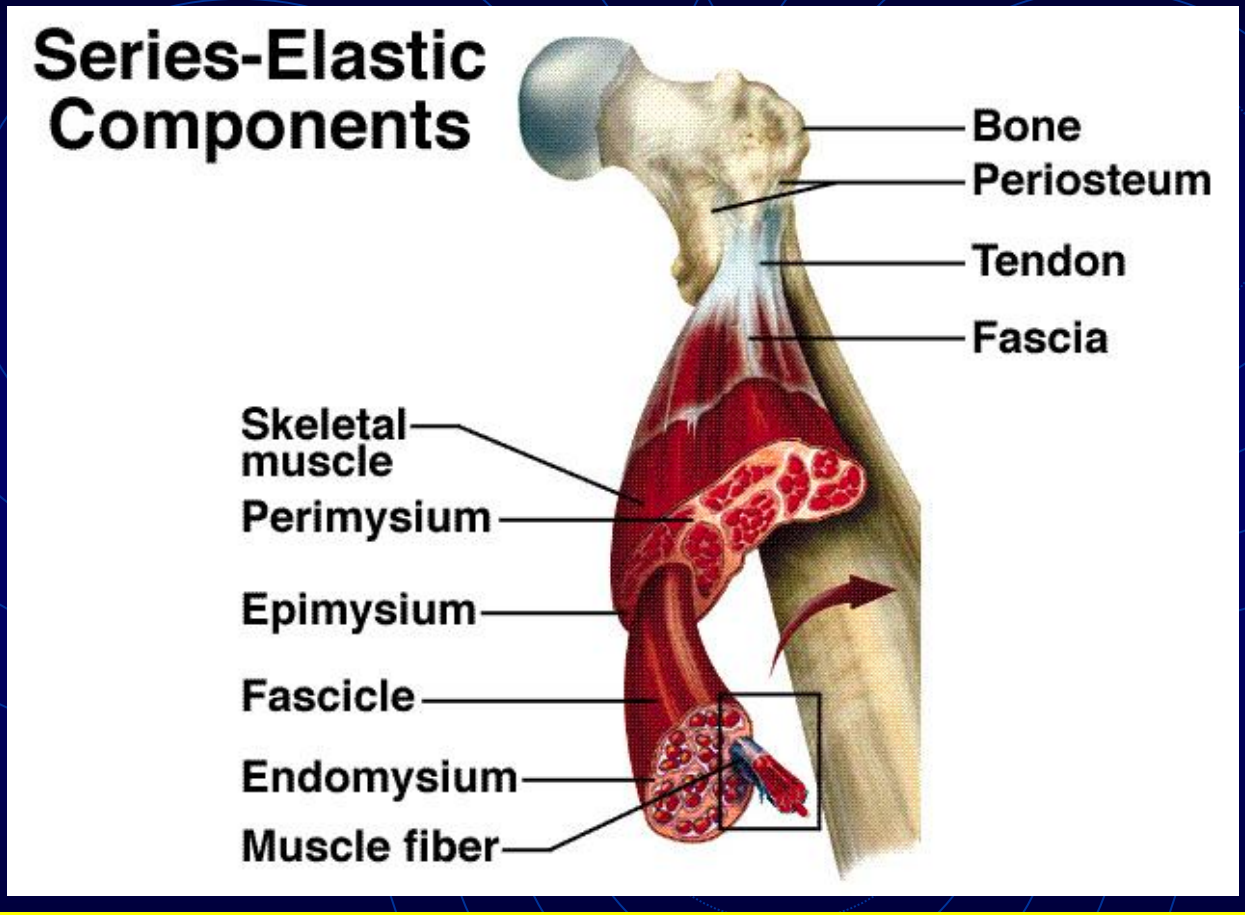
myo

Function of Skeletal Muscles

1. Skeletal movement
2. Posture and body position
3. Support of soft tissues
4. Joint Stabilization
5. Guarding of entrances & exits
6. Maintenance of body temperature
7. Protection
8. Facial expression



Gross to Microscopic Anatomy



Each skeletal muscle cell (fiber) is wrapped by 3 layers of connective tissue.

Epi-, Peri-, and Endomysium

Are interwoven -

- **Continuous with tendon, and eventually the periosteum**

Distinguish between:

- **Tendon**
- **Aponeurosis**
- **Ligament**

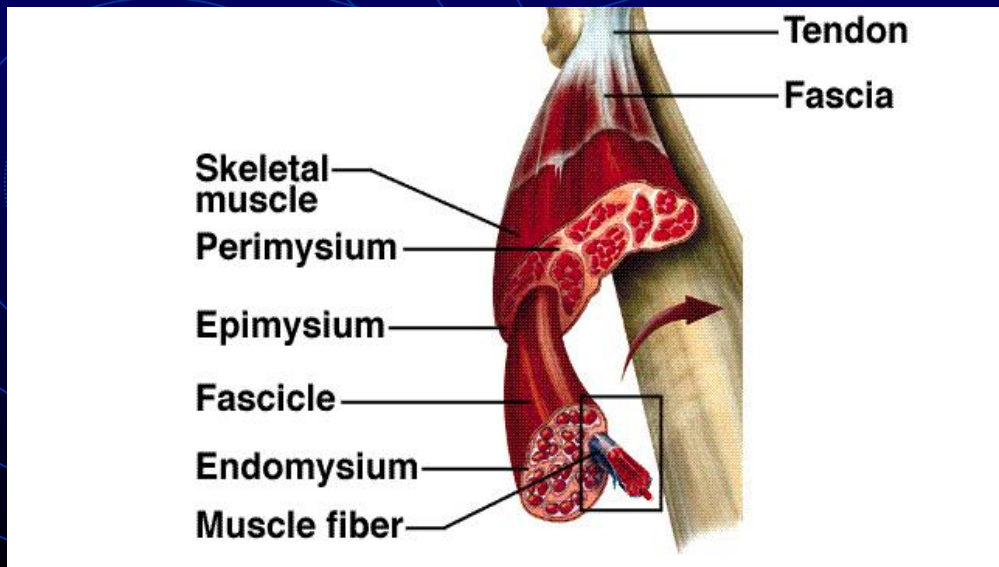
Function:

- **Protection**
- **Blood supply**
- **Innervation**

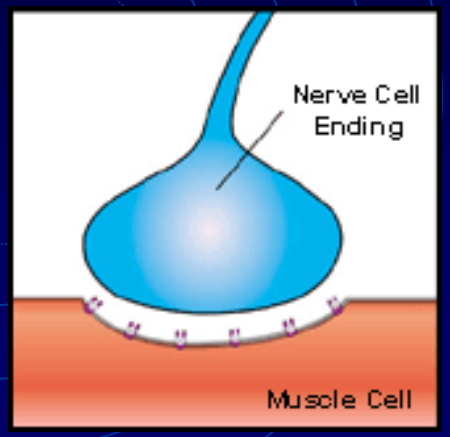
Epimysium = On top of the muscle

Perimysium = Around a bundle of myofibers

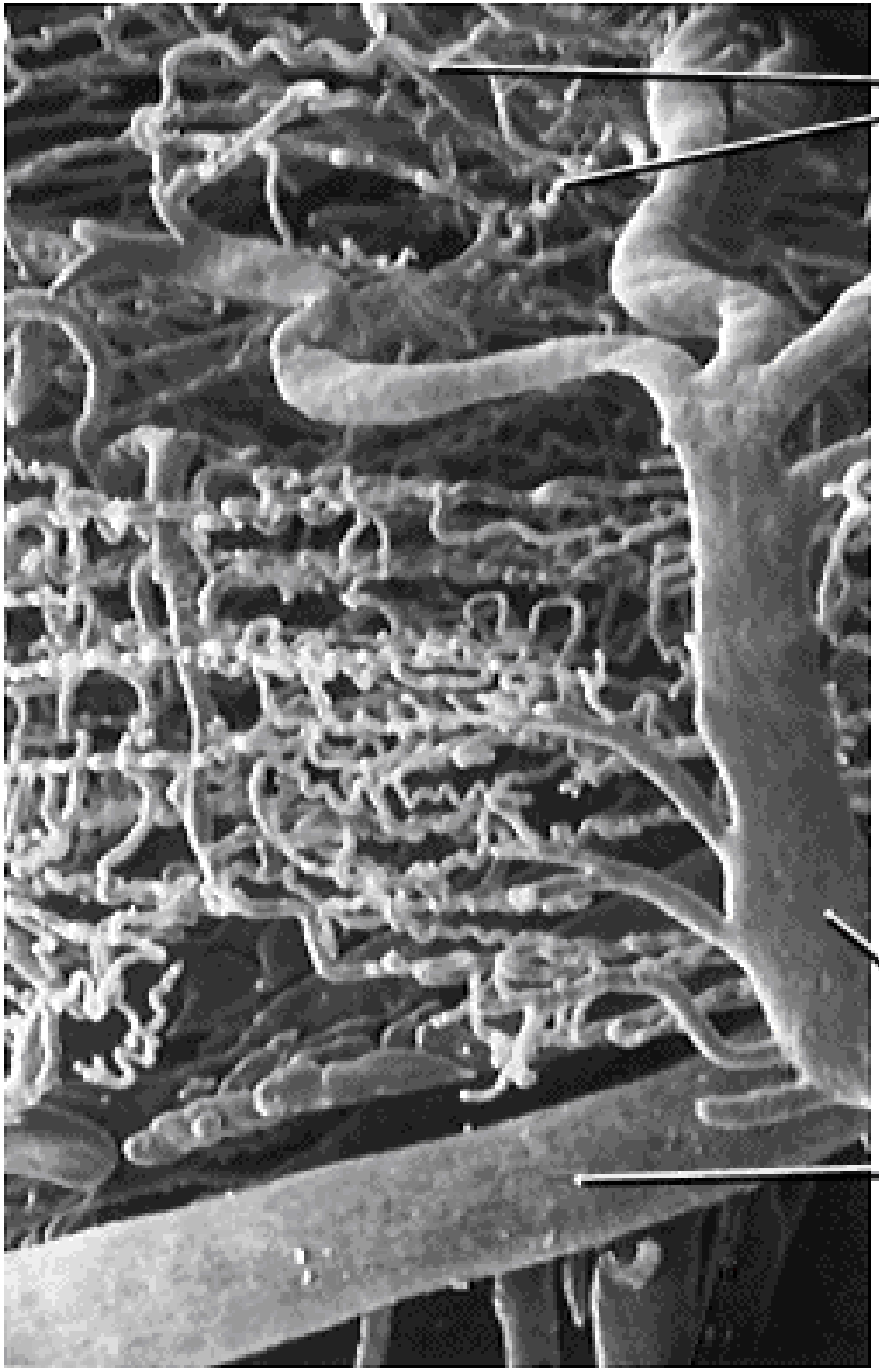
Endomysium = Surrounds each myofiber



Nerve and Blood Supply



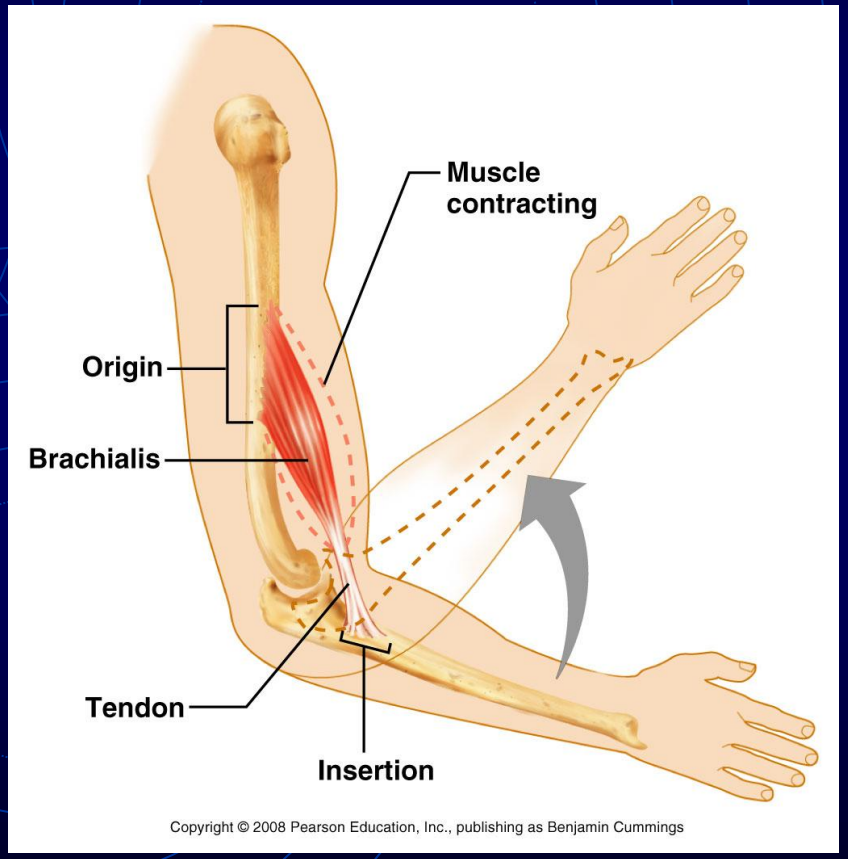
- Skeletal muscles are rich in nerves and blood vessels.
- Chemical communication at neuromuscular junction
- Synaptic terminal of axon meets motor end plate of muscle cell
- Coiled capillaries are able to adapt to changes in length of muscle fiber



Coiled Capillaries

Origin and Insertion

- Origin:
  - The part that stays still
  - Usually proximal
- Insertion:
  - The part that moves
  - Usually distal



Microanatomy of Skeletal Muscle Fibers

Some vocabulary:

Skeletal muscle cell = fiber or myofiber

Sarcolemma

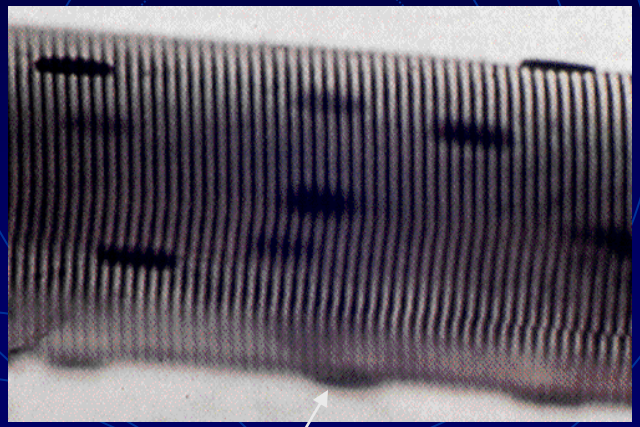
Sarcoplasm

Sarcoplasmic reticulum

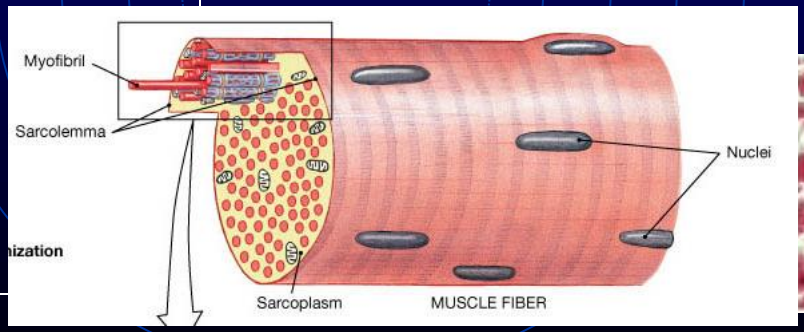
Myofibril

Myofilaments

T-tubules



Multiple nuclei on periphery



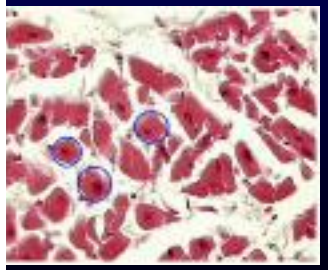
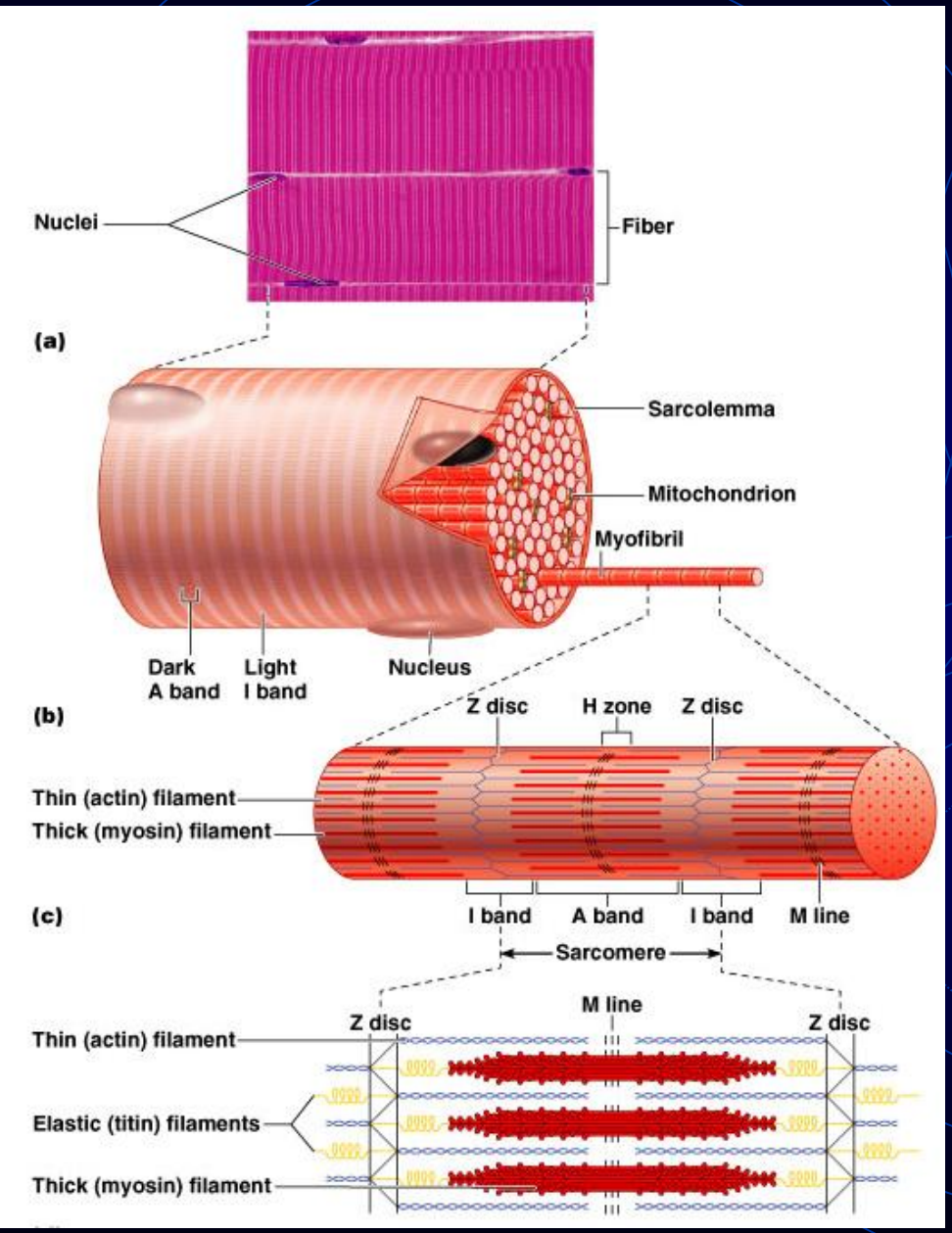
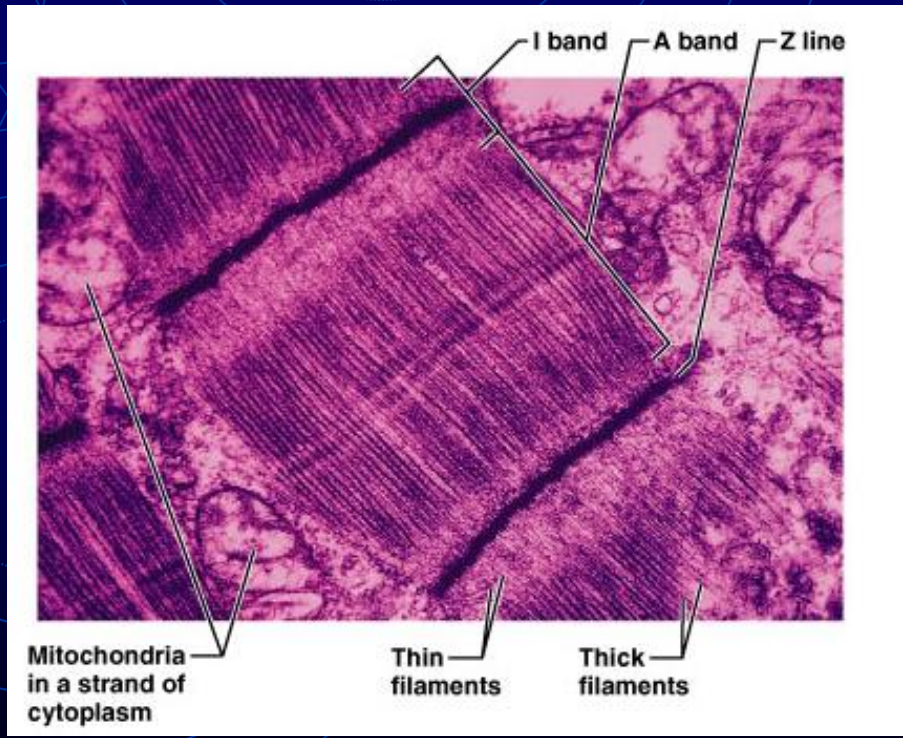


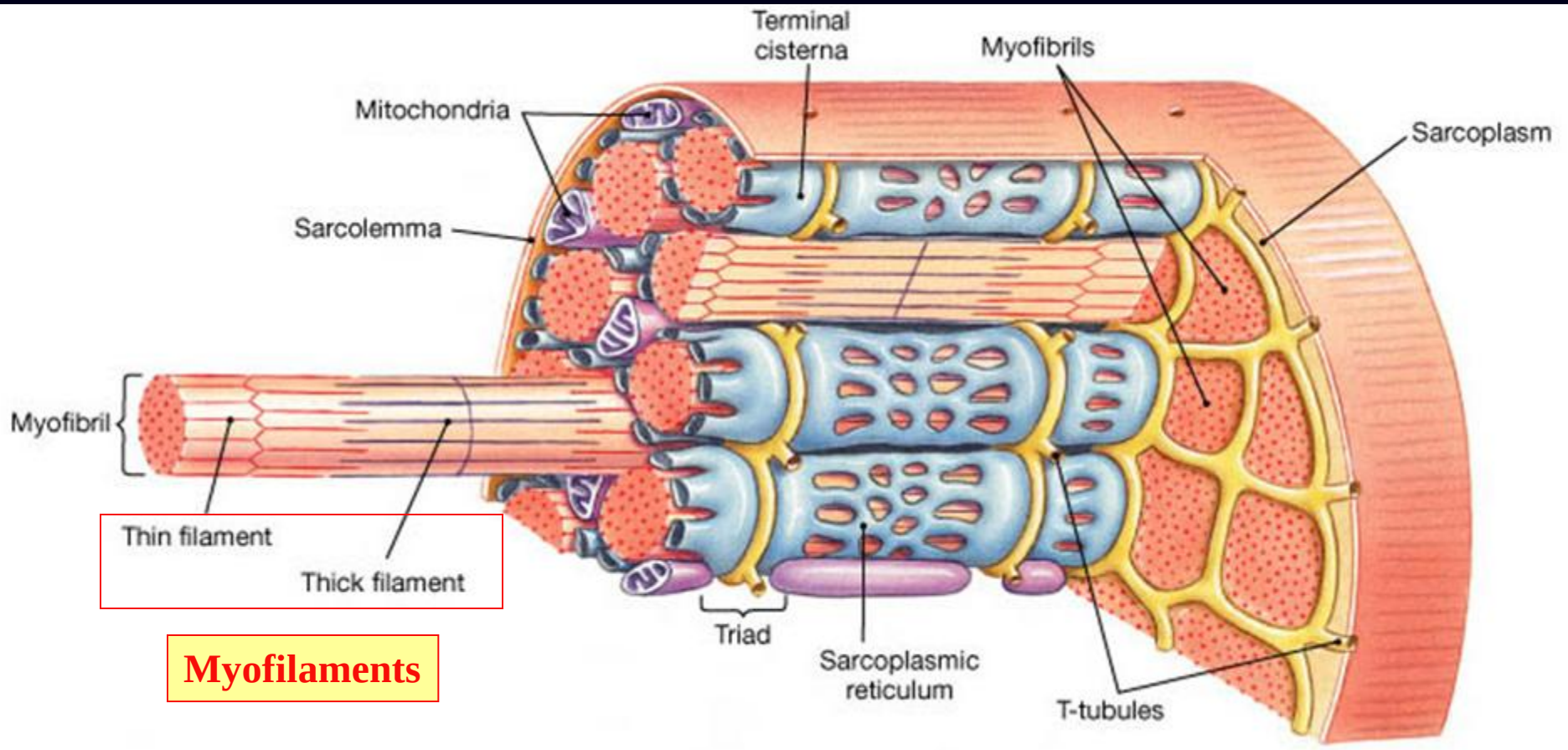
Fig. 10.4



Microanatomy

Myofiber (= cell)
Myofibrils
Myofilaments





Myofilaments

Myofiber (cell) → **Myofibrils** → **Myofilaments**

Actin & Myosin

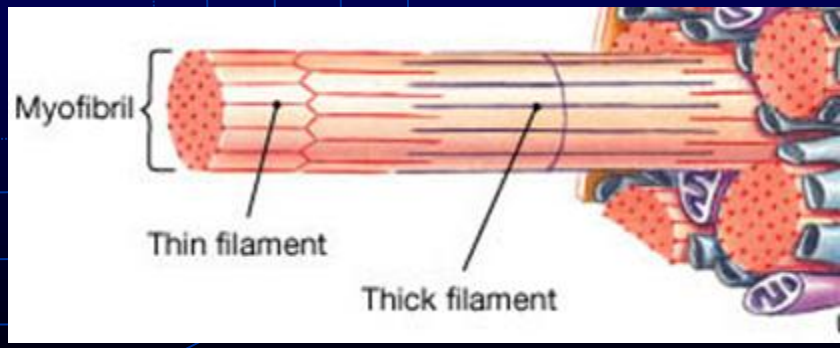
Sarcomere (= thick + thin filaments)

Thick and Thin Filaments are organized in repeating functional units

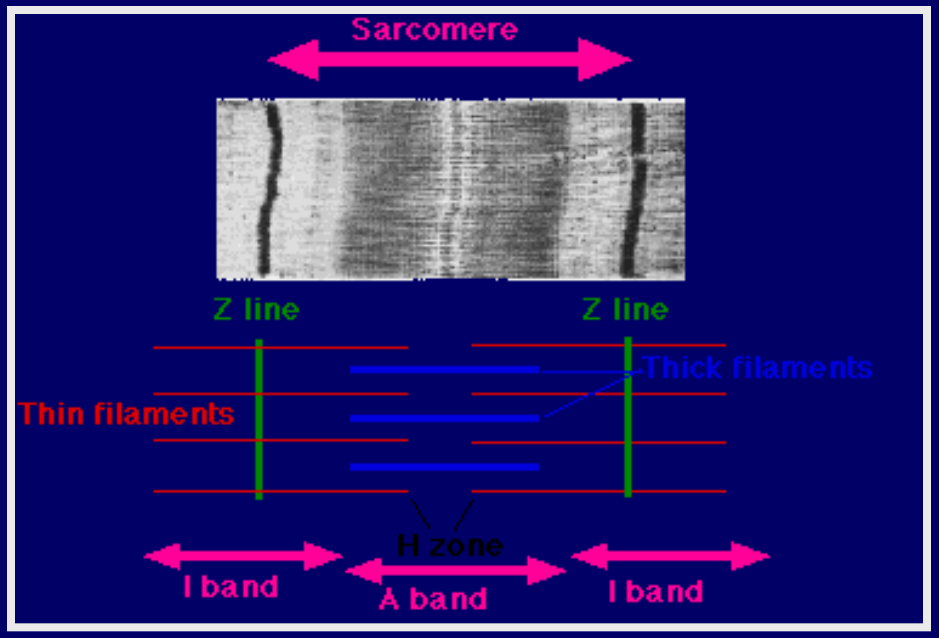
Each myofibril has linear arrangement of up to 10,000 sarcomeres

Banded appearance (striation) due to arrangement of thick and thin filaments

Interaction of thick and thin filaments responsible for skeletal muscle fiber contraction



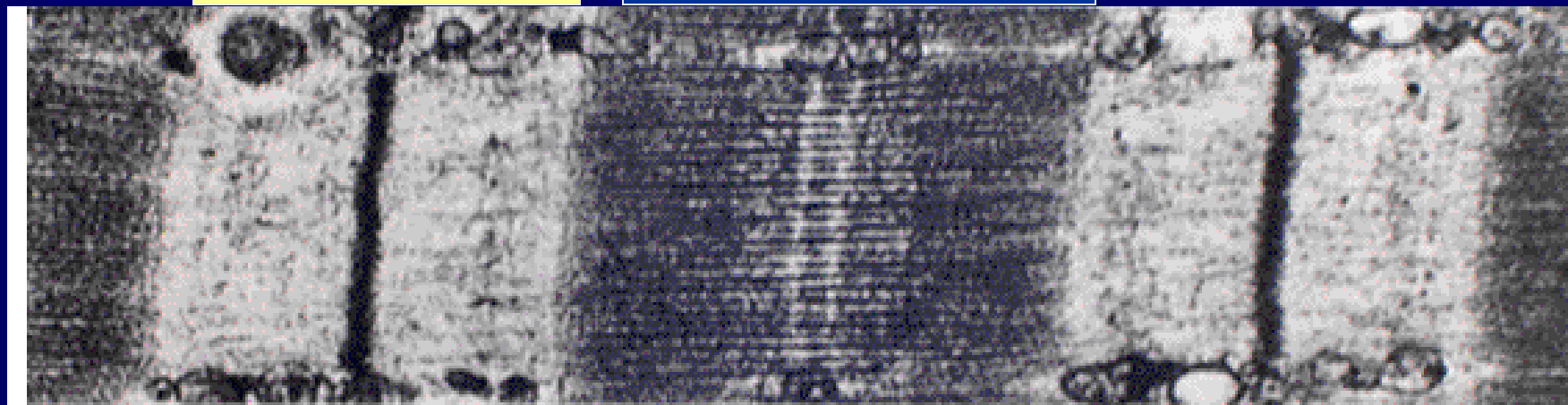
Sarcomere Structure



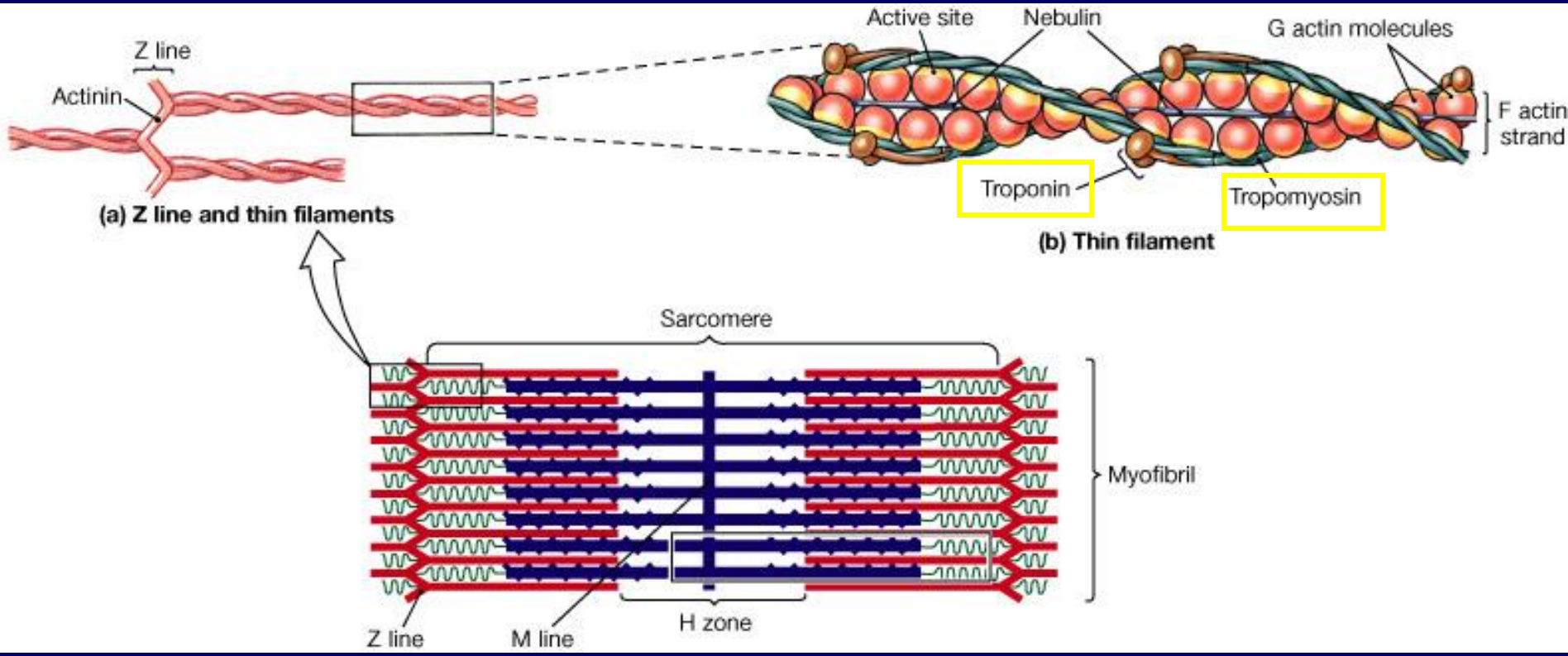
I - band
= lIght band

A- band
= dArk band

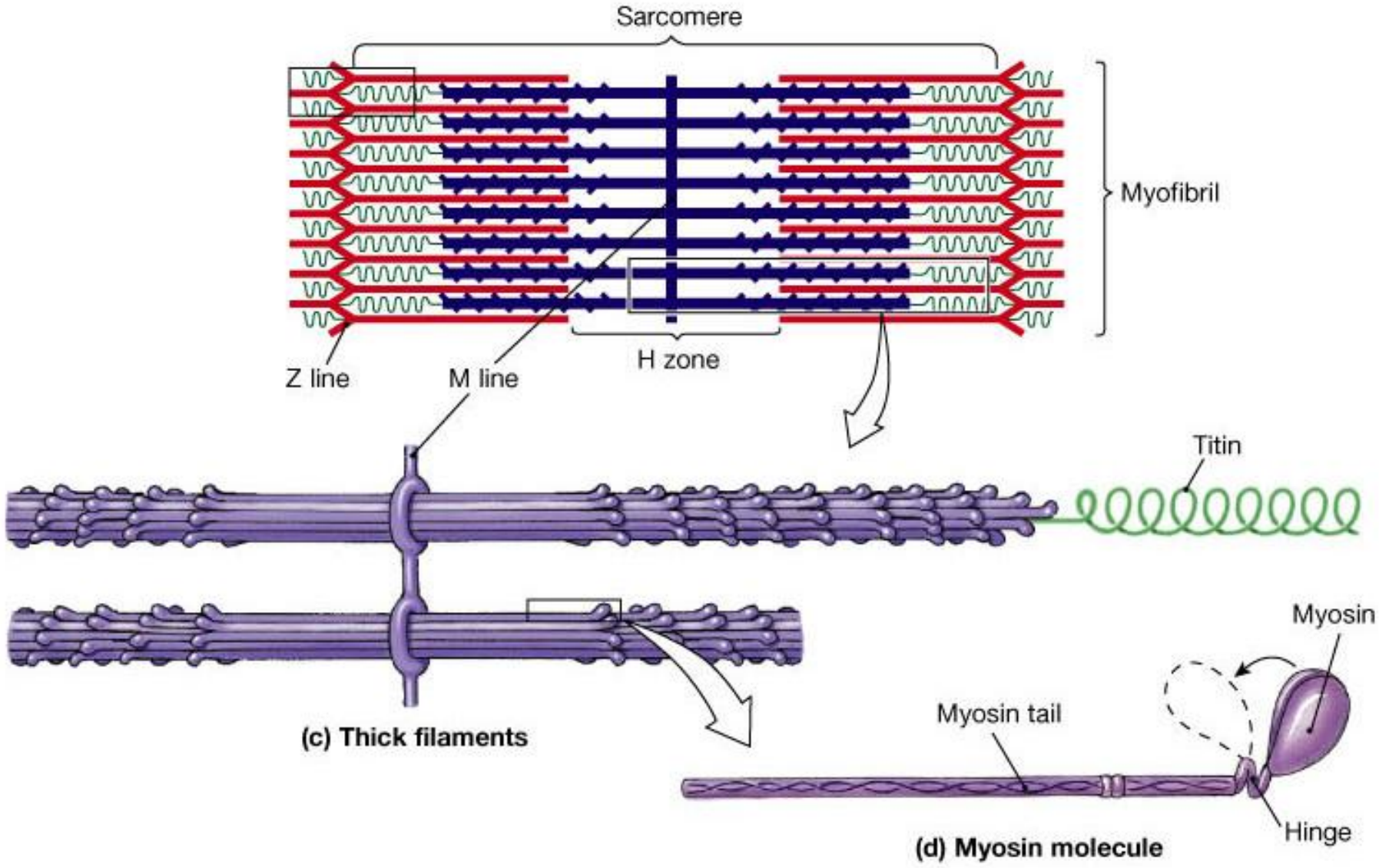
Z - line



Thin Filament: Actin



Thick Filament: Myosin



Motor Unit

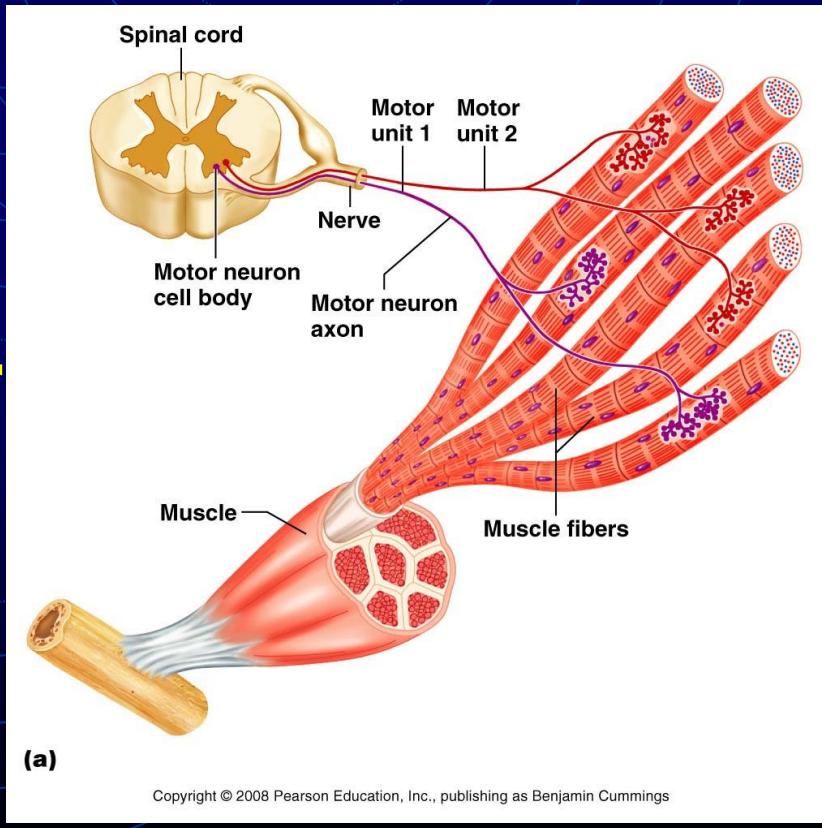
= All muscle fibers that are controlled by a single motor neuron (axon)

The lower the ratio of muscle fibers to neurons, the more precise the movement can be.

Ratio is from 1:1 to 1:2000

Acetylcholine is the neurotransmitter at the motor end plate

Contraction of a motor unit is “all or none.”



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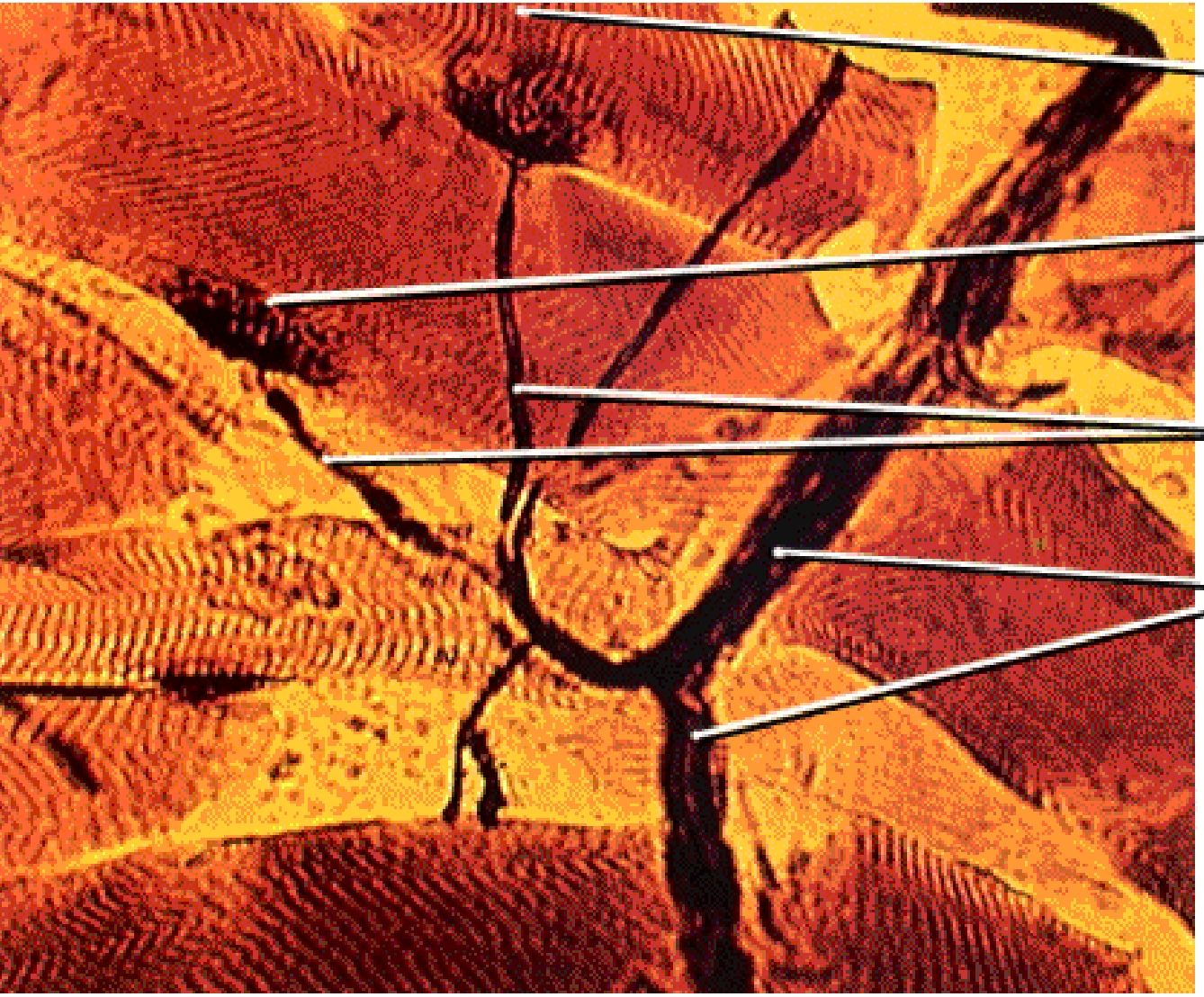

Skeletal muscle fibers
Neuromuscular junction
Axons
Nerve
LM x230

Muscle Control

Muscle tone = Resting tension of skeletal muscles
(continuous contraction of some motor units to maintain some muscle tension)

Recruitment or Multiple motor unit summation for greater force

Some directional control depending on which motor units are stimulated

Muscle Hypertrophy vs. Atrophy

Hypertrophy due to anaerobic exercise

Leads to increased muscle size - *how?*

Atrophy if supply of myofilaments exceeds demand. Muscle fibers become smaller and weaker.

Eventual death of muscle fibers is irreversible!

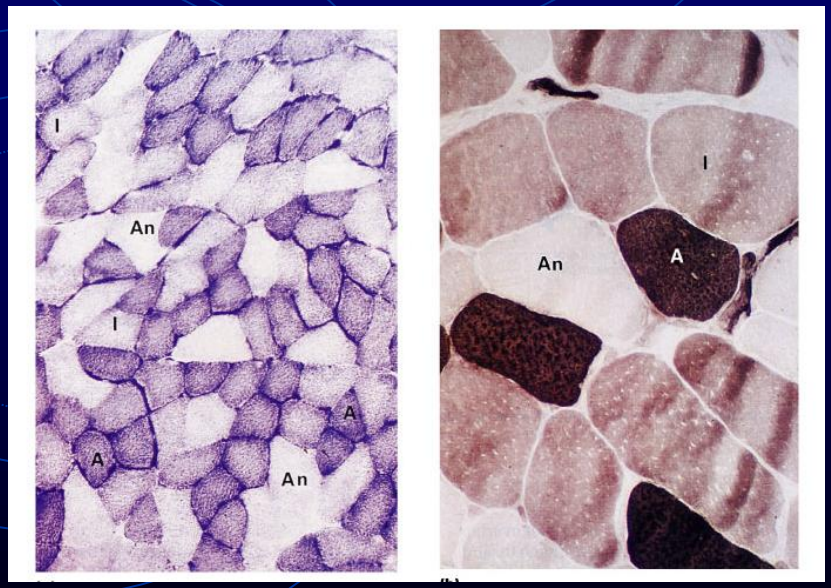
Importance of Physical Therapy

Three Types of Skeletal Muscle Fibers (fast, slow, intermediate)

1. **Slow (or Red) OxidativeFibers Type I**
2. **Fast Glycolytic Fibers Type Iix**
3. **Fast Oxidative Fibers Type IIa**

Most skeletal muscles contain mixture of fiber types.
Proportion of fast to slow depends on training and development

One motor unit only contains one fiber type

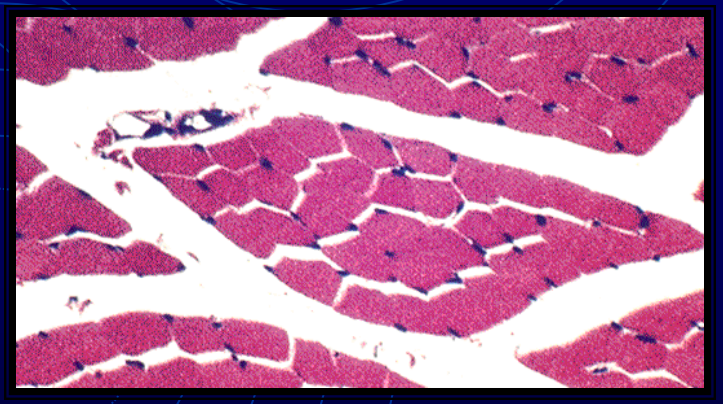


1. Slow (or Red) Oxidative Fibers Type I

Slow but continuous contraction for extended periods

Smaller diameter (~ half)

- contain myoglobin
- more capillaries
- more mitochondria



Do not fatigue as fast due to aerobic production of ATP

2. Fast Glycolytic Fibers Type IIx

Fast contraction after nervous stimulation

Large diameter

- large glycogen reserve
- fewer mitochondria
- densely packed myofibrils

Fatigue fast due to mainly anaerobic respiration

3. Fast Oxidative Fibers Type IIa

Have attributes in between fast and slow types

Organization (shape) of Skeletal Muscle Fibers

Effect of individual muscle contraction determined by:

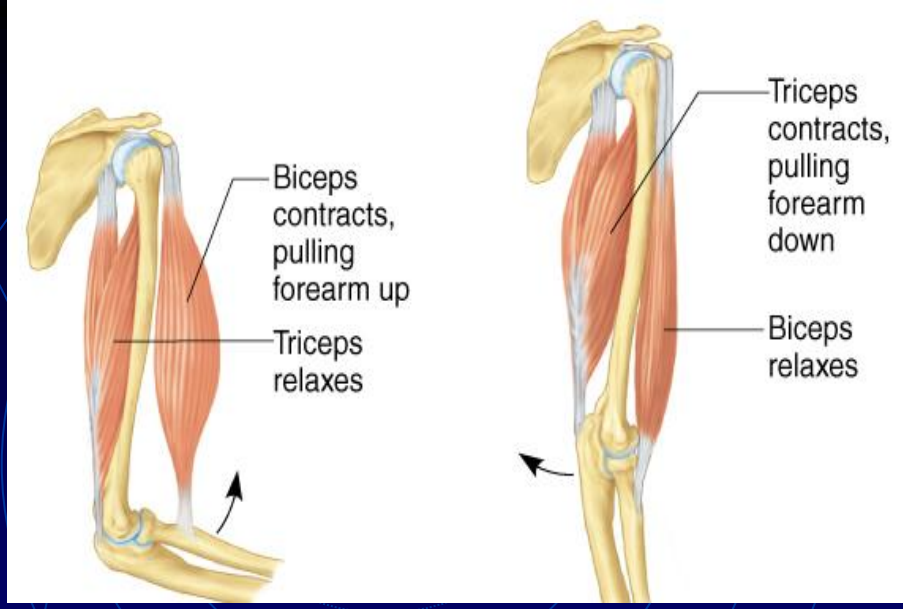
1. arrangement of muscle fibers
2. method of attachment to skeleton

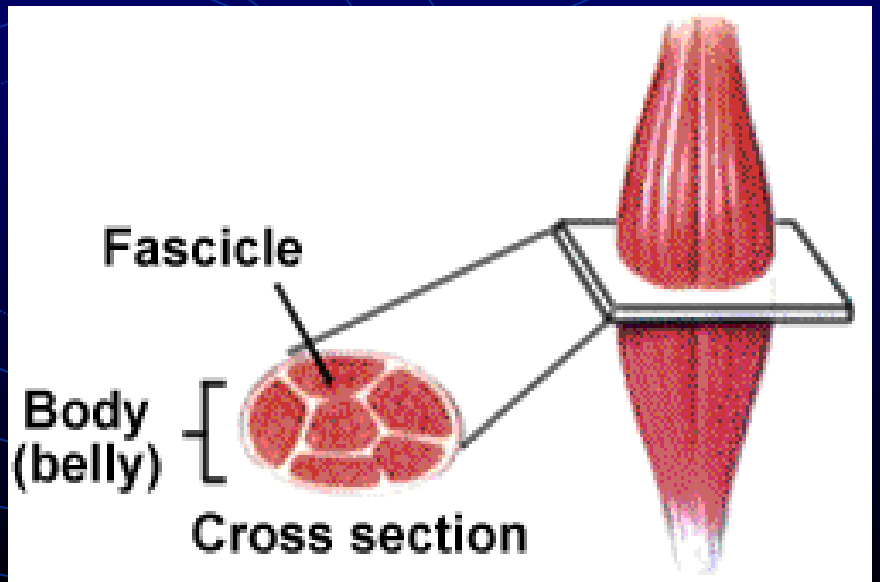
Bundles of muscle fibers =fascicle

Muscle fibers within 1 fascicle are parallel

Parallel Muscles

- Extensor vs. flexor
- Origin vs. Insertion
- Spindle shaped with cord-like tendons
- Some flat bands with broad attachments on each end



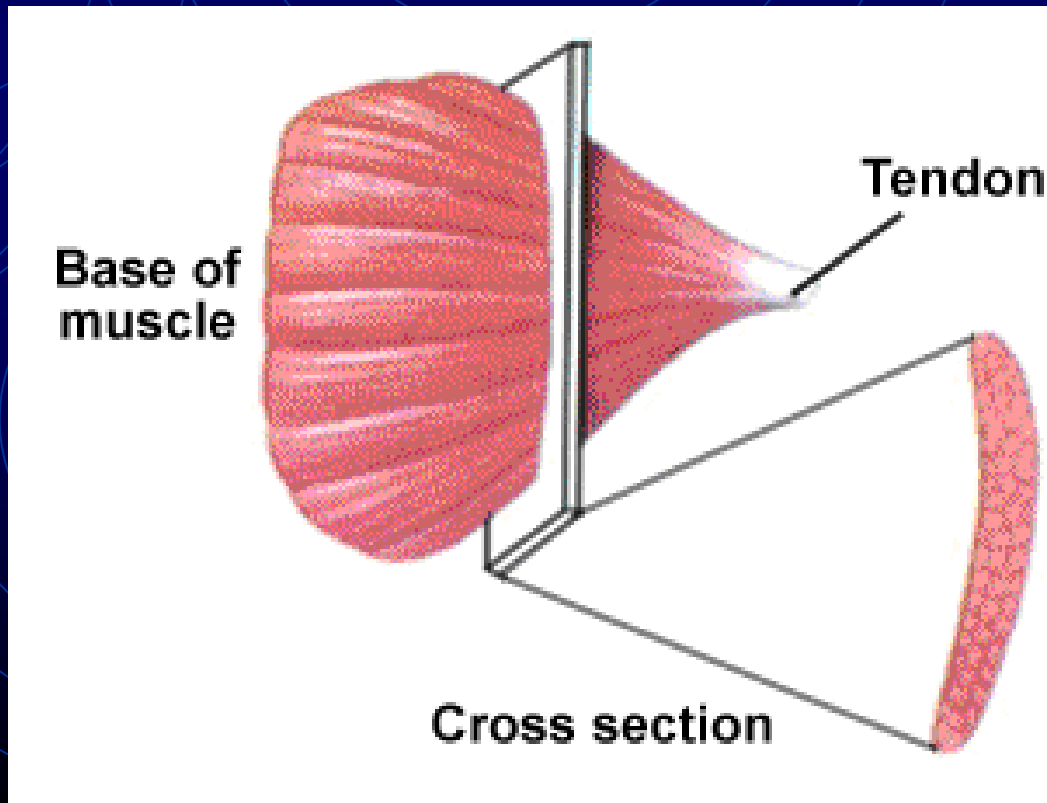


Convergent muscles

Broad origin, pointed insertion

Direction of pull can be varied: versatility!!

Example = deltoid



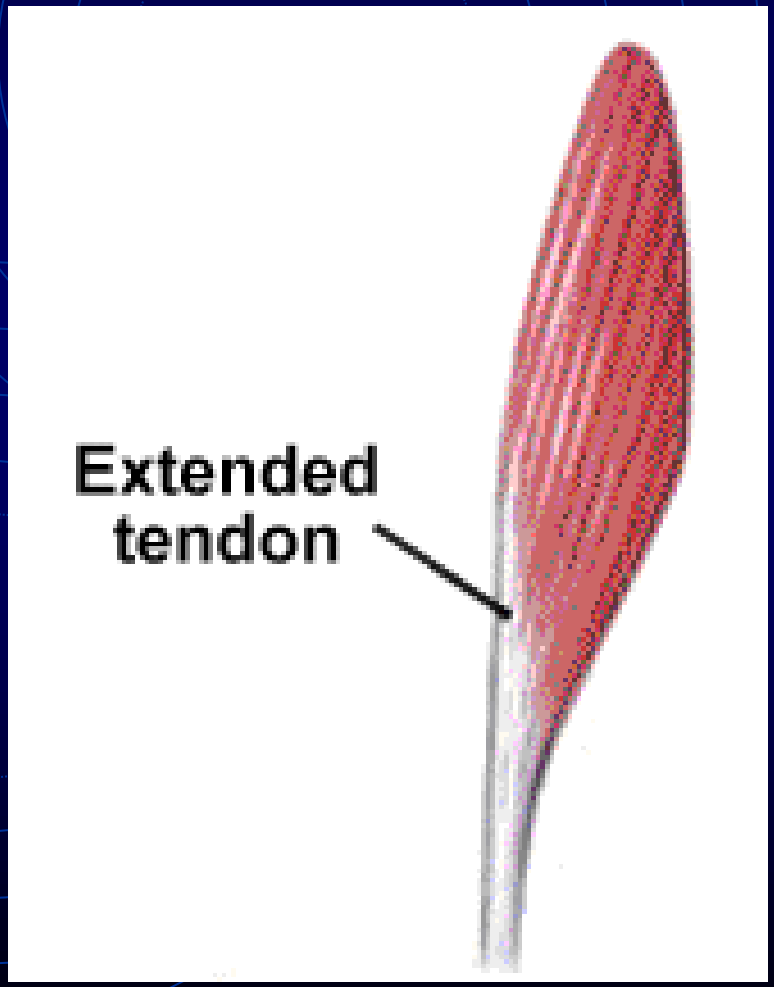
Pennate Muscles: Unipennate

One or more tendons run though muscle body

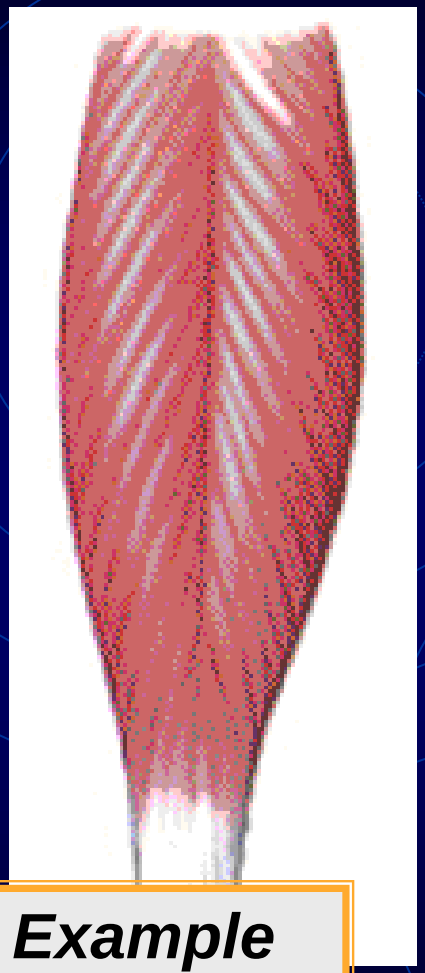
Fascicles in oblique angle to tendon

Can generate more tension

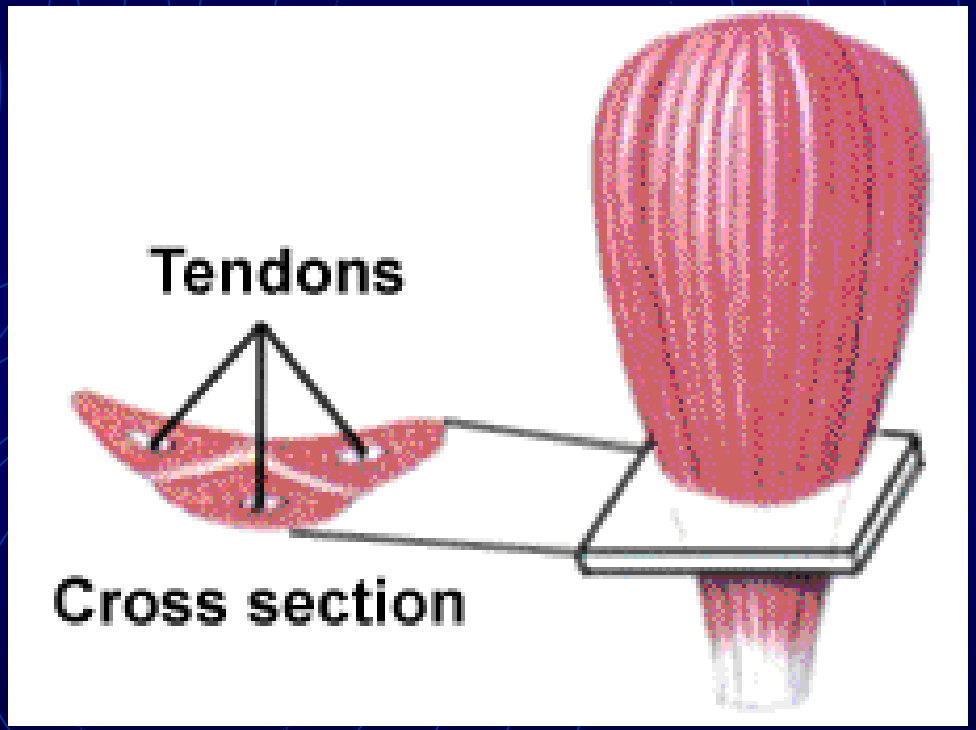
Example = biceps brachii



Pennate Muscles: Bipennate & Multipennate



Example



Example

Muscle Terminology

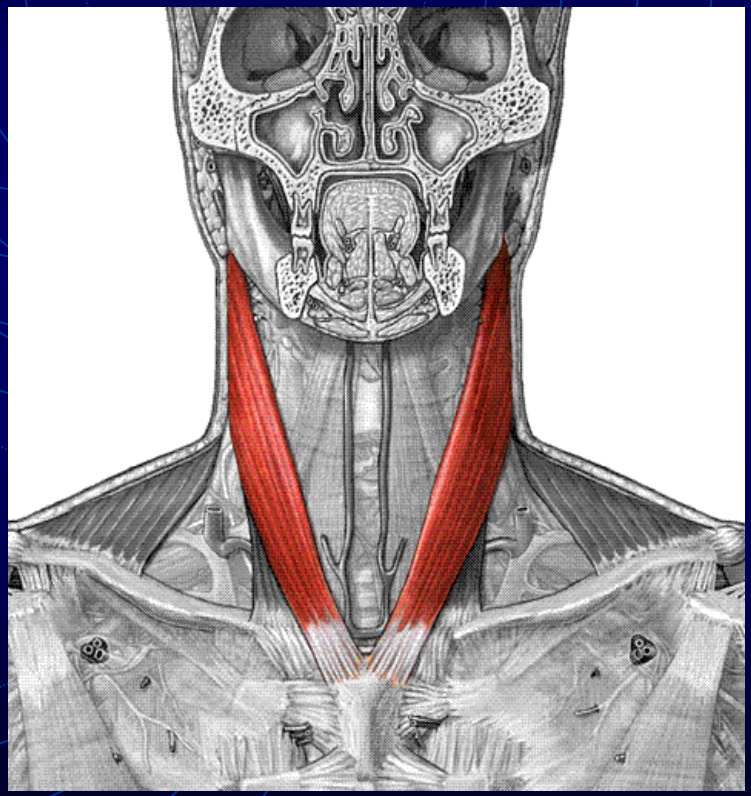
Flexor ⇒ **Extensor**

Origin ⇒ **Insertion**

Agonist ⇒ **Antagonist**

Synergist

- **Possible: multiple origins**
- **Note: Agonist = Prime Mover**

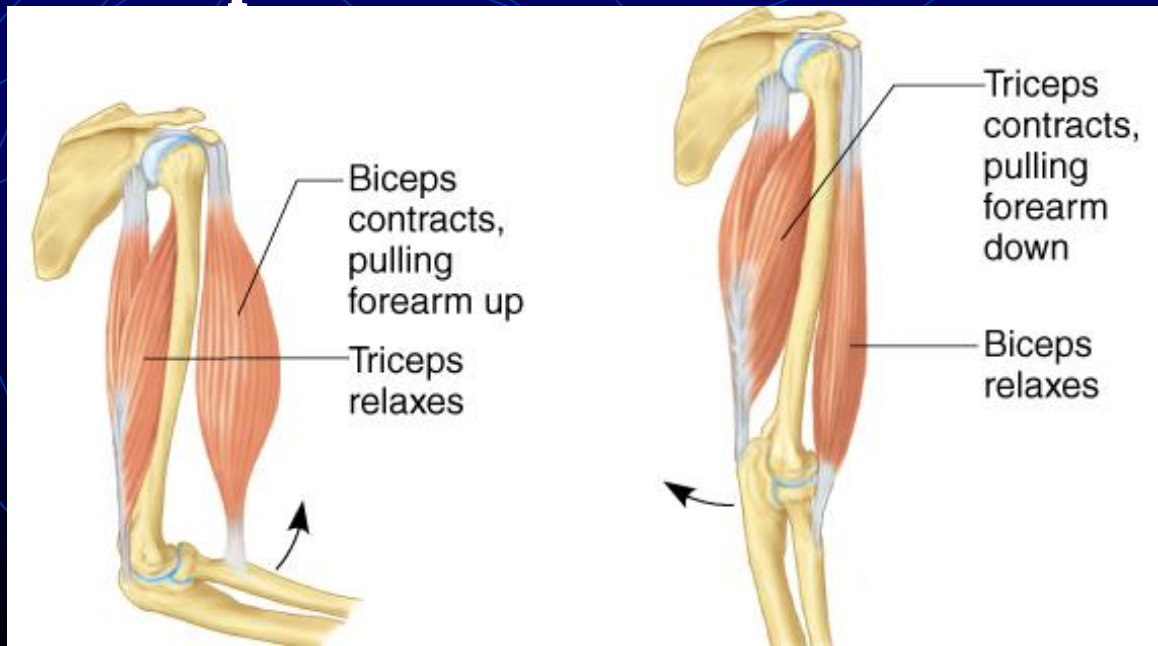


Grouping of Muscles according to Primary Action

Agonist = Prime Mover

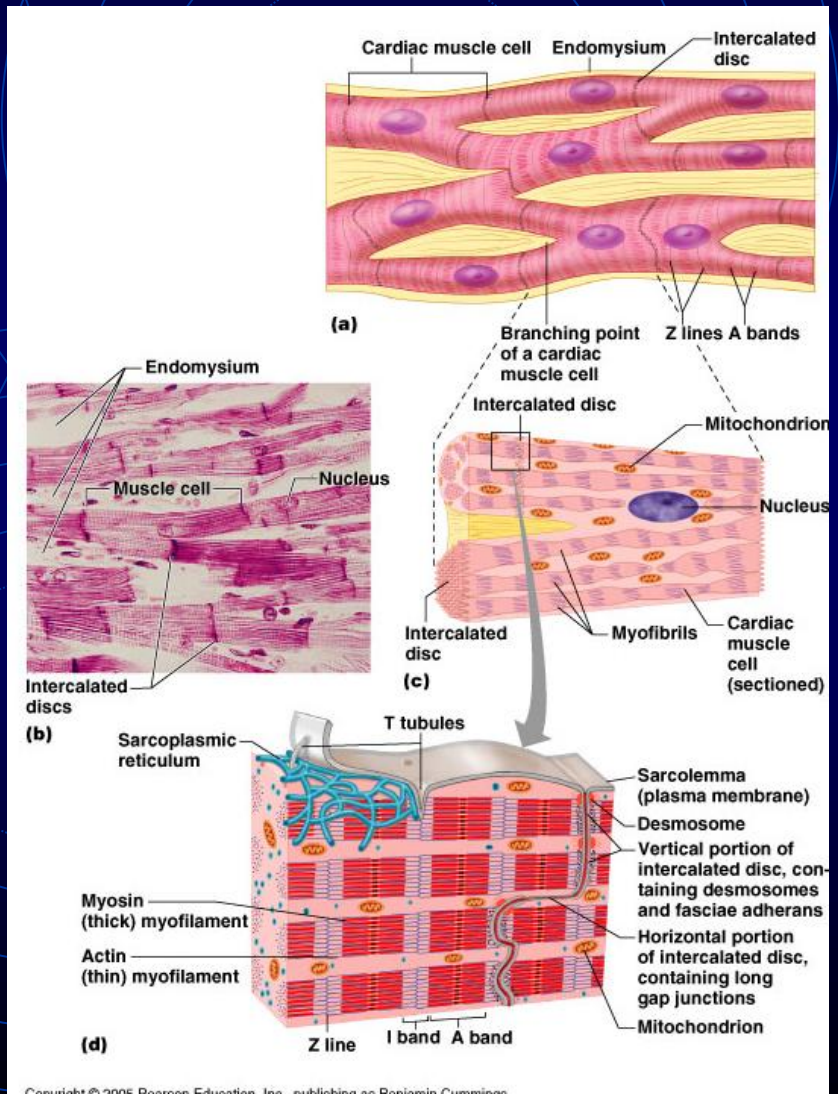
Antagonist (action opposes agonist)

Synergists = Assistants of prime mover



Cardiac Muscle

- Form the Myocardium
- Striated, involuntary
- Single cells
  - Branched extensively
  - Joined with Intercalated Disks (provide communication with gap junctions)
- Similar filament structure to Skeletal M.
  - Not as organized
  - Nuclei in the middle of the cells



Smooth Muscle

- Nonstriated, involuntary
- Internal organs (mostly)
- Single Cells called fibers
- Often in opposing layers
  - Gut, bladder